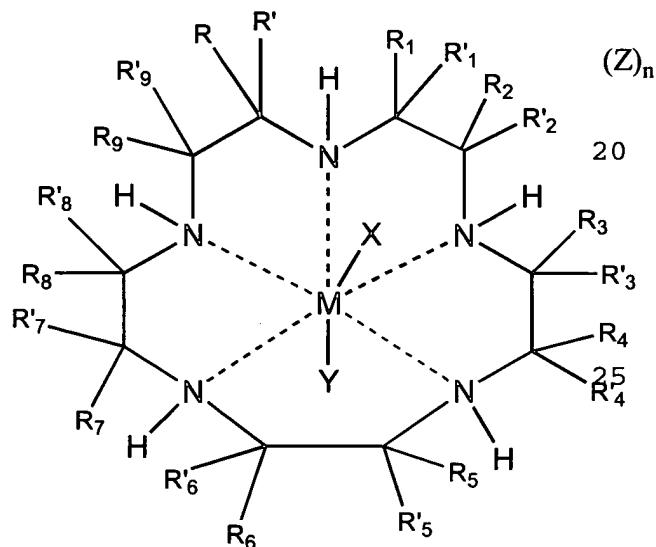


## WHAT IS CLAIMED IS:

1. A modified biopolymer comprising a biopolymer chosen from the group consisting of chitin, chitosan, cellulose, methyl cellulose, hyaluronic acid, keratin, fibroin, collagen, elastin, and saccharide polymers attached to at least one non-proteinaceous catalyst capable of dismutating superoxide in the biological system or precursor ligand thereof.

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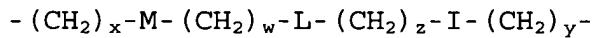
2. The modified biopolymer of claim 1, wherein the non-proteinaceous catalyst capable of dismutating superoxide in the biological system is selected from the group consisting of manganese and iron chelates of pentaazacyclopentadecane compounds, which are represented by the following formula:



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wherein M is a cation of a transition metal, preferably manganese or iron; wherein R, R', R<sub>1</sub>, R'<sub>1</sub>, R<sub>2</sub>, R'<sub>2</sub>, R<sub>3</sub>, R'<sub>3</sub>, R<sub>4</sub>, R'<sub>4</sub>, R<sub>5</sub>, R'<sub>5</sub>, R<sub>6</sub>, R'<sub>6</sub>, R<sub>7</sub>, R'<sub>7</sub>, R<sub>8</sub>, R'<sub>8</sub>, R<sub>9</sub>, and R', independently represent hydrogen, or substituted or unsubstituted alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkenyl, cycloalkylalkyl, cycloalkylcycloalkyl, cycloalkenylalkyl, alkylcycloalkyl, alkylcycloalkenyl,

alkenylcycloalkyl, alkenylcycloalkenyl, heterocyclic, aryl and aralkyl radicals; R<sub>1</sub> or R'<sub>1</sub> and R<sub>2</sub> or R'<sub>2</sub>, R<sub>3</sub> or R'<sub>3</sub> and R<sub>4</sub> or R'<sub>4</sub>, R<sub>5</sub> or R'<sub>5</sub> and R<sub>6</sub> or R'<sub>6</sub>, R<sub>7</sub> or R'<sub>7</sub>, and R<sub>8</sub> or R'<sub>8</sub>, and R<sub>9</sub> or R'<sub>9</sub>, and R or R' together with the carbon atoms to which they are attached independently form a substituted or unsubstituted, saturated, partially saturated or unsaturated cyclic or heterocyclic having 3 to 20 carbon atoms; R or R' and R<sub>1</sub> or R'<sub>1</sub>, R<sub>2</sub> or R'<sub>2</sub> and R<sub>3</sub> or R'<sub>3</sub>, R<sub>4</sub> or R'<sub>4</sub> and R<sub>5</sub> or R'<sub>5</sub>, R<sub>6</sub> or R'<sub>6</sub> and R<sub>7</sub> or R'<sub>7</sub>, and R<sub>8</sub> or R'<sub>8</sub> and R<sub>9</sub> or R'<sub>9</sub>, together with the carbon atoms to which they are attached independently form a substituted or unsubstituted nitrogen containing heterocycle having 2 to 20 carbon atoms, provided that when the nitrogen containing heterocycle is an aromatic heterocycle which does not contain a hydrogen attached to the nitrogen, the hydrogen attached to the nitrogen as shown in the above formula, which nitrogen is also in the macrocyclic ligand or complex, and the R groups attached to the included carbon atoms of the macrocycle are absent; R and R', R<sub>1</sub> and R'<sub>1</sub>, R<sub>2</sub> and R'<sub>2</sub>, R<sub>3</sub> and R'<sub>3</sub>, R<sub>4</sub> and R'<sub>4</sub>, R<sub>5</sub> and R'<sub>5</sub>, R<sub>6</sub> and R'<sub>6</sub>, R<sub>7</sub> and R'<sub>7</sub>, R<sub>8</sub> and R'<sub>8</sub>, and R<sub>9</sub> and R'<sub>9</sub>, together with the carbon atom to which they are attached independently form a saturated, partially saturated, or unsaturated cyclic or heterocyclic having 3 to 20 carbon atoms; and one of R, R', R<sub>1</sub>, R'<sub>1</sub>, R<sub>2</sub>, R'<sub>2</sub>, R<sub>3</sub>, R'<sub>3</sub>, R<sub>4</sub>, R'<sub>4</sub>, R<sub>5</sub>, R'<sub>5</sub>, R<sub>6</sub>, R'<sub>6</sub>, R<sub>7</sub>, R'<sub>7</sub>, R<sub>8</sub>, R'<sub>8</sub>, R<sub>9</sub>, and R'<sub>9</sub>, together with a different one of R, R', R<sub>1</sub>, R'<sub>1</sub>, R<sub>2</sub>, R'<sub>2</sub>, R<sub>3</sub>, R'<sub>3</sub>, R<sub>4</sub>, R'<sub>4</sub>, R<sub>5</sub>, R'<sub>5</sub>, R<sub>6</sub>, R'<sub>6</sub>, R<sub>7</sub>, R'<sub>7</sub>, R<sub>8</sub>, R'<sub>8</sub>, R<sub>9</sub>, and R'<sub>9</sub>, which is attached to a different carbon atom in the macrocyclic ligand may be bound to form a strap represented by the formula



wherein w, x, y and z independently are integers from 0 to 10 and M, L and I are independently selected from the group consisting of alkyl, alkenyl, alkynyl, aryl,

cycloalkyl, heteroaryl, alkaryl, alkheteroaryl, aza,  
amide, ammonium, oxa, thia, sulfonyl, sulfinyl,  
sulfonamide, phosphoryl, phosphinyl, phosphino,  
phosphonium, keto, ester, alcohol, carbamate, urea,  
5 thiocarbonyl, borates, boranes, boraza, silyl, siloxy,  
silaza and combinations thereof; and combinations  
thereof;

and wherein X, Y and Z are independently selected  
10 from the group consisting of halide, oxo, aquo, hydroxo,  
alcohol, phenol, dioxygen, peroxy, hydroperoxy,  
alkylperoxy, arylperoxy, ammonia, alkylamino, arylamino,  
heterocycloalkyl amino, heterocycloaryl amino, amine  
oxides, hydrazine, alkyl hydrazine, aryl hydrazine,  
15 nitric oxide, cyanide, cyanate, thiocyanate, isocyanate,  
isothiocyanate, alkyl nitrile, aryl nitrile, alkyl  
isonitrile, aryl isonitrile, nitrate, nitrite, azido,  
alkyl sulfonic acid, aryl sulfonic acid, alkyl sulfoxide,  
aryl sulfoxide, alkyl aryl sulfoxide, alkyl sulfenic  
20 acid, aryl sulfenic acid, alkyl sulfinic acid, aryl  
sulfinic acid, alkyl thiol carboxylic acid, aryl thiol  
carboxylic acid, alkyl thiol thiocarboxylic acid, aryl  
thiol thiocarboxylic acid, alkyl carboxylic acid (such as  
acetic acid, trifluoroacetic acid, oxalic acid), aryl  
25 carboxylic acid (such as benzoic acid, phthalic acid),  
urea, alkyl urea, aryl urea, alkyl aryl urea, thiourea,  
alkyl thiourea, aryl thiourea, alkyl aryl thiourea,  
sulfate, sulfite, bisulfate, bisulfite, thiosulfate,  
thiosulfite, hydrosulfite, alkyl phosphine, aryl  
30 phosphine, alkyl phosphine oxide, aryl phosphine oxide,  
alkyl aryl phosphine oxide, alkyl phosphine sulfide, aryl  
phosphine sulfide, alkyl aryl phosphine sulfide, alkyl  
phosphonic acid, aryl phosphonic acid, alkyl phosphinic  
acid, aryl phosphinic acid, alkyl phosphinous acid, aryl  
35 phosphinous acid, phosphate, thiophosphate, phosphite,  
pyrophosphate, triphosphate, hydrogen phosphate,  
dihydrogen phosphate, alkyl guanidino, aryl guanidino,

alkyl aryl guanidino, alkyl carbamate, aryl carbamate,  
alkyl aryl carbamate, alkyl thiocarbamate aryl  
thiocarbamate, alkyl aryl thiocarbamate, alkyl  
dithiocarbamate, aryl dithiocarbamate, alkyl aryl  
5 dithiocarbamate, bicarbonate, carbonate, perchlorate,  
chlorate, chlorite, hypochlorite, perbromate, bromate,  
bromite, hypobromite, tetrahalomanganate,  
tetrafluoroborate, hexafluorophosphate,  
hexafluoroantimonate, hypophosphite, iodate, periodate,  
10 metaborate, tetraaryl borate, tetra alkyl borate,  
tartrate, salicylate, succinate, citrate, ascorbate,  
saccharinate, amino acid, hydroxamic acid, thiosylate,  
and anions of ion exchange resins.

15 3. The modified biopolymer of claim 2, wherein the  
biopolymer is hyaluronic acid.

4. The modified biopolymer of claim 2, wherein the  
biopolymer is an ester of hyaluronic acid.

20 5. The modified biopolymer of claim 4, wherein the  
ester of hyaluronic acid is chosen from the group  
consisting of total esters and partial esters.

25 6. The modified biopolymer of claim 4, wherein the  
ester of hyaluronic acid is a benzyl ester.

7. A thread comprising the modified biopolymer of  
claim 4.

30 8. A polymeric matrix structure comprising the  
modified biopolymer of claim 4.

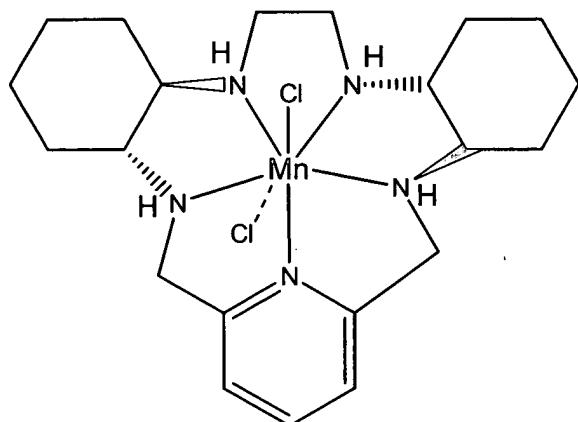
9. A neural growth guide channel comprising the modified biopolymer of claim 4.

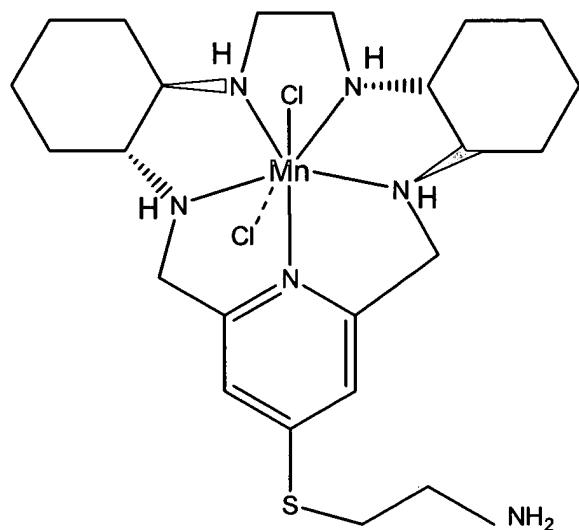
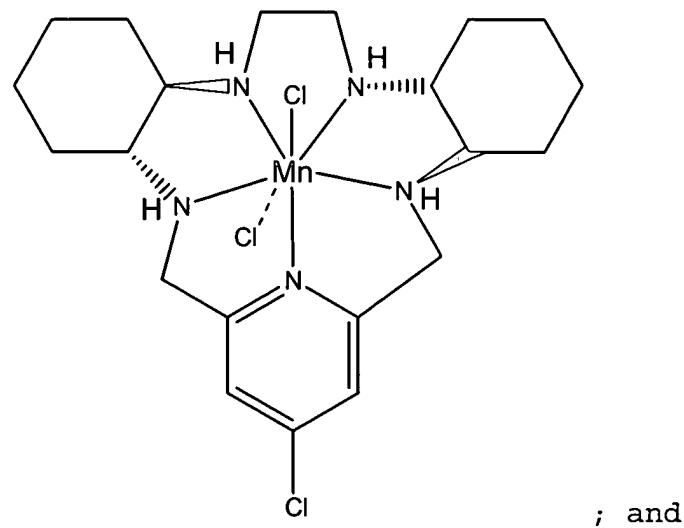
10. A method for in vivo regrowth of nerve tissue  
5 in a subject in need thereof comprising placement of the neural growth guide channel of claim 9 in the subject under conditions sufficient to stimulate regrowth of nerve tissue.

10 11. The modified biopolymer of claim 2, wherein the non-proteinaceous catalyst capable of dismutating superoxide comprises a reactive moiety to provide a means for covalent conjugation to the unmodified biopolymer.

15 12. The modified biopolymer of claim 11, wherein the reactive moiety is chosen from the group consisting of amino, carboxyl, isocyanate, mercapto, hydroxy, silyl chloride, acid halide, halide, glycidyl, and substituted or unsubstituted alkenyl, alkynyl, and aryl.

20 13. The modified biopolymer of claim 2, wherein the non-proteinaceous catalyst capable of dismutating superoxide is chosen from the group consisting of:

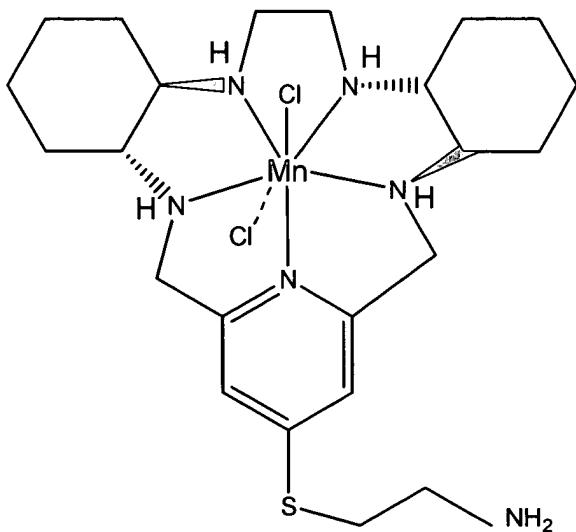




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14. Modified hyaluronic acid prepared by reaction of hyaluronic acid with a non-proteinaceous catalyst capable of dismutating superoxide having the structure:

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or a precursor ligand thereof under conditions appropriate to covalently attach the non-proteinaceous catalyst capable of dismutating superoxide to the hyaluronic acid.

15. A pharmaceutical composition comprising the modified biopolymer of claim 1 and a pharmaceutically acceptable carrier or diluent.

16. A pharmaceutical composition comprising the compound of claim 13 and a pharmaceutically acceptable carrier or diluent.

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17. A pharmaceutical composition comprising the modified hyaluronic acid of claim 14 and a pharmaceutically acceptable carrier or diluent.

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18. A method for treating joint pain in a subject in need thereof comprising administering to the subject the pharmaceutical composition of claims 15, 16, or 17.

19. A method for treating osteoarthritis in a subject in need thereof comprising administering to the subject the pharmaceutical composition of claims 15, 16, or 17.

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20. A method for treating inflammation in a subject in need thereof comprising administering to the subject the pharmaceutical composition of claims 15, 16, or 17.

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21. The method of claim 18, wherein the pharmaceutical composition is administered to the subject by injection.

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22. The method of claim 19, wherein the pharmaceutical composition is administered to the subject by injection.

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23. The method of claim 20, wherein the pharmaceutical composition is administered to the subject by injection.